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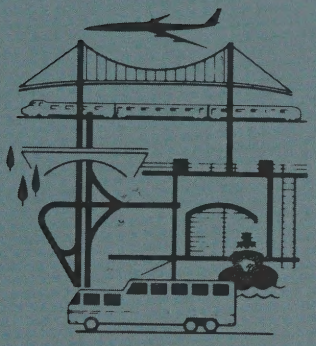
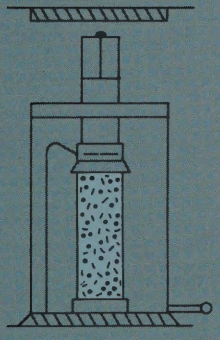
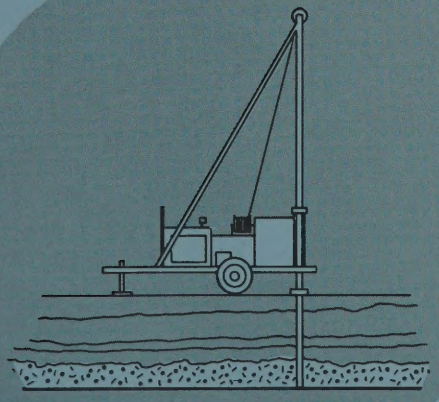


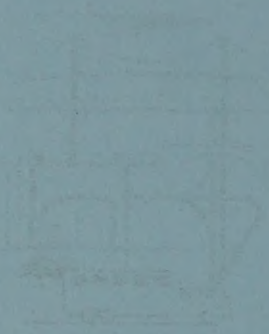


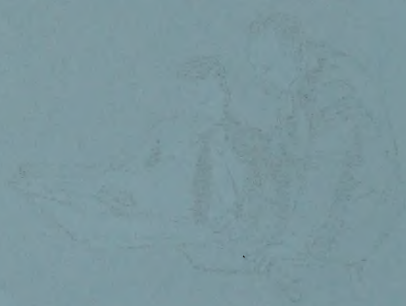


PRELIMINARY STRUCTURE FOUNDATION REPORT
I-87/I-84 INTERCHANGE RECONSTRUCTION
PIN 8720.33
TOWN OF NEWBURGH
ORANGE COUNTY

December 2002

GE 238 (2/95)





PRELIMINARY STRUCTURE FOUNDATION REPORT

I-87/I-84 INTERCHANGE RECONSTRUCTION

PIN 8720.33

TOWN OF NEWBURGH

ORANGE COUNTY

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PROJECT DESCRIPTION

The project consists of the reconstruction of the interchange between the New York State Thruway, Interstate Route 87 and Interstate Route 84. This project involves the construction of numerous new ramps and access roads, two new toll plazas, a new tandem truck area and several new buildings for the Thruway. It also includes several walls, six new structures and the widening of one existing structure.

RESOURCES

Several sources of information were used in the preparation of the this report:

- Orthographic Photos of the area
- Surficial Soil Maps
- Draft of the Terrain Reconnaissance Report
- Topographic Maps
- Plans for the original construction of the interchange and I-84
- Historic subsurface explorations for original construction
- Historic subsurface explorations for the reconstruction of Union Avenue
- Subsurface explorations obtained for this project.

SOIL CONDITIONS

The soils in the area are identified as a Mardin gravelly silt loam, a glacial till. There are glacial lake deposits mapped in the area of the Thruway. However, they appear to have been modified by the construction of Thruway and I-84.

The general profile consists of:

Name	Thickness - m	Density	Description
Surface Till	One to Four	Medium Compact to Compact	Silty SAND Gravelly
Dense Till	Four to Five	Very Compact	Mixtures of Silty GRAVEL Sandy; Sandy GRAVEL Silty and Sandy GRAVEL
Decomposed Rock	0.5	Very Compact	Decomposed Shale
Rock	--	---	Shale and Siltstone - Normanskill Formation

DISCUSSION OF POSSIBLE FOUNDATIONS

ABUTMENTS

General

The abutments are to be supported on spread footings. The abutments on the existing fills would be designed for 250 kPa and a coefficient of sliding of 0.55. The abutments supported by the MSES can be designed for 200 kPa and a coefficient of sliding of 0.55. Engineering Instruction 99-025 (and the NYSDOT Bridge Manual) permits the use of MSES to support spread footings. The backfills used in the construction of MSES volumes are frost free materials. Therefore, we recommend that footings should be surface footings instead of being embedded 1.2 meters. For preliminary span length determination, locate the abutment so the minimum distance between the centerline of bearings and the front of the MSE panel is 2.3 m and the minimum distance between the footing and the back of the MSE panel is 600 mm. We would also direct the designer to BD sheet EE-12-R1 for details.

Waiting Periods

Most of the abutments will require short waiting periods to address small settlements. The abutments in conventional embankments should be constructed and backfilled to subgrade, then observe a two week waiting period before setting the pedestals. This will allow for whatever settlement has taken place to be absorbed in the pedestal construction. The remaining settlement will be less than a centimeter.

Waiting Periods for MSES walls

Abutments on MSES embankments can be addressed one of two ways. The same procedure as the abutments built on conventional embankments (described above) may be used. The other method involves building the embankment to subgrade prior to abutment construction, utilizing either a panel or wire faced MSES wall at the back of the stem. At this time there would be a two week waiting period to allow the embankments to settle before abutment construction. The abutment can then be designed virtually as a pier, i.e., without earth pressure acting to cause overturning or sliding of the abutment.

PIERS

We have considered four possible foundation solutions for the piers:

- Shallow spread footings in the loose till(no treatment)
- Shallow spread footings in the loose till (with treatment)
- Shallow footings supported on piles
- Deep spread footings on the dense till

Shallow Foundations without Treatment

In general the shallow foundations without treatment have the potential for settlements in excess of 25 mm and some potential for differential settlement between substructures.

Shallow Foundations with Treatment

Possible treatments involve undercutting the proposed pier area, rolling the bottom of the undercut and then backfilling with compacted select material.

Pile Types

Piles are considered for some of the structures where it appeared that the piles would be long enough to be practical. Both H-Piles and Cast-In-Place piles were considered.

The H-piles would be the largest size for a given flange width with design load based on the smallest section in that flange width, such as using an HP 250x85 to support the load that would be imposed on an HP 250x62. This would give more steel area to avoid over stressing the piles during installation. However, these piles will very likely have a large variation in their installed lengths, since it is difficult to predict how the end bearing will attained. If the end bearing is based upon the steel area of the cross-section, some of the piles would have to be driven to rock, through the dense till. If, however, a plug of material forms in the flanges then the pile would require less embedment. Since splices are a pay item for this type of pile, when there is an increase of 1.5 meters over the estimated length, we are not recommending this pile type.

Instead we recommend using a Cast-In-Place pile not unlike the piles used for the original parkway projects in the lower part of Westchester County. These would be a thick walled pipe fitted with a 60° conical point. These piles would be driven into the surface of the dense till and stop. This should result in a more consistent pile length.

Spread Footings on the Dense Till

Some of the proposed footings are already at an elevation where they would bear on the dense tills. Other proposed footings will require excavations. Some of these excavations are far enough away from existing facilities that they can be open cut. Others are in the median of I-84 and will either require closing a lane and diverting traffic or progressing a braced excavation. This type of excavation will require two rows of bracing. The lower row could be removed once the footing is cast and backfilled. The second (upper) row of bracing will either require a substantial waler, which will permit struts on either side of the pier stem, or will require "windows" or a construction joint in the pier stem to accommodate the struts.

COMMENTS ON MSES WALLS

There are abutments where the MSES walls make acute angles between the abutments and return walls. It creates a situation where the suppliers have to physically tie the return wall panels to the abutment wall panels since there is nowhere to put the reinforcing. This violates the tenets of mechanically stabilized earth.

A review of the various abutments indicates that these walls fall into that category:

Bridge		Wall Location	Possible Relocation
No.	Description		
2	WB-NS over I-84, Ramp EB-L and Access B	Northwest Wingwall	Move wall to where the embankments meet and place a small slope on top of the wall.
3	NS-WB over I-84 and Ramp WB-NS	Northeast Wingwall	Flare the wall to meet the embankment at a right angle.
5	L-NS over Access Road B and Ramp EB-L	Northeast Wingwall	No solution available

FOUNDATION RECOMMENDATIONS BY STRUCTURE

Bridge No. 1 Ramp EB-NS over I-87 and Access Road B

West Abutment

The west abutment will be designed with spread footings on a 1.5 m thick pad of Select Structure Fill (Item 203.21). The foundation will be designed for a maximum allowable bearing pressure of 250 kPa and a coefficient of sliding of 0.55. Superstructure settlement will be less than a centimeter, using the construction procedure outlined in "Waiting Periods".

Pier One

This pier may be designed for a maximum allowable bearing pressure of 400 kPa and a coefficient of friction of 0.55. It also should be constructed on 1.5 m thick pad of Select structure Fill (Item 203.21). Settlement will be less than a centimeter.

Pier Two

A spread footing at the elevation depicted on the structure study plan (Elev. 105.2±) would result in a settlement of 14 mm or almost double the amount estimated for the other substructures. Therefore two other foundation options for this pier were considered:

- Support the pier on a spread footing on the dense till
- Placed the pier on cast-in-place piles

A footing on the dense till would be at elevation 102.2± and designed for the maximum allowable bearing pressure of 600 kPa and a coefficient of sliding of 0.55. This foundation will result in settlements of less than a centimeter.

If the pier is to be pile supported, the bottom of footing elevation should be 108.2±, which would result in piles with an estimated length of six meters. Piles could be either 324 mm diameter CIP with a design load of 450 kN or 356 mm diameter CIP with a design load of 630 kN. These piles will supply an uplift resistance of 65 and 88 kN and a lateral resistance of 6.2 and 7.3 kN/pile respectively.

Pier Three

This pier can be supported at the elevation depicted on a spread footing designed for 600 kPa allowable bearing pressure and a coefficient of sliding of 0.55. However, if the designers would prefer a pile foundation then the footing should be raised to elevation 108.8 m and would result in a pile length of three meters. The same piles could be used.

East Abutment

This abutment will be designed with spread footings on a MSES embankment. The footings will be designed for a maximum allowable bearing pressure of 200 kPa and a coefficient of 0.55. The settlement will be less than a centimeter using either of the construction procedures outline in "Waiting Periods for MSES walls".

Conclusions and Recommendations

Location	Bottom of Footing, elevation m.	Foundation Type	Bearing pressure or Pile Load	Comments
West Abutment	115.8	Spread	250 kPa	1.5 m pad of 203.21
Pier One	112.7	Spread	400 kPa	1.5 m pad of 203.21
Pier Two	108.2	Piles 356 mm CIP	630 kN	Less problems than a 7m deep strutted to minimize impact in the wetlands
Pier Three	104.5	Spread	600 kPa	
East Abutment	116.9	Spread	200 kPa	

Bridge No. 2 Ramp WB-NS over I-84 EB and WB, Ramps EB-L & Access Road B

Abutments

Support the North and South Abutments on spread footings on MSES embankment. Design the footings for a maximum allowable bearing pressure of 200 kPa and a coefficient of friction of 0.55. The settlements will be less than a centimeter with the construction procedures outlined in "Waiting Periods for MSES walls".

Whichever waiting period procedure is used at the south abutment it should be the same as that for the south abutment of bridge no. 5 since they share an MSES approach embankment.

The Piers

Support Pier One and Pier Two on a spread footing designed for a maximum allowable bearing pressure of 600 kPa , a coefficient of sliding of 0.55 and a bottom of footing elevation 110.9 m and 111.0m respectively. Depending on the final footing width, it may be possible to construct pier one in an open cut, with side slopes having an inclination of one vertical on one and half horizontal.

Conclusions and Recommendations

Location	Bottom of Footing, elevation	Foundation Type	Bearing Pressure or Pile Load	Comments
South Abutment	119.4	Spread	200 kPa	
Pier One	111.0	Spread	600 kPa	Open cut w/ 1 on 1.5 sides
Pier Two	111.0	Spread	600 kPa	Open cut w/ 1 on 1.5 sides
East Abutment	118.4	Spread	200 kPa	

Bridge 3 Ramp NS-WB over I-84 and Ramp WB-NS

Abutments

Support the abutments on spread footings on MSES embankments. Design the footings for a maximum allowable bearing pressure of 200 kPa and a coefficient of sliding of 0.55 The settlements will be less than a centimeter with the above procedures described in "Waiting Periods for MSES walls".

However, if the shallow foundations for the piers are chosen, then the construction sequence for the abutment should be adjusted to permit the abutments to be backfilled after beam placement. This will result in the minimum differential settlement between the substructures in the final condition. However, this may not be practical since Bridge Three and Bridge Four share the same abutment and require different construction procedures.

Pier One

This pier can be supported on a spread footing at elevation 108.9 and designed for a maximum allowable bearing pressure of 450 kPa and a coefficient of sliding of 0.55. This footing would be constructed on a 1.5 m thick pad of select structure fill (Item 203.21) in a safety berm in the center of the median of I-84. In order to minimize settlement, the existing ground under the pier location needs to be excavated to a depth of 1.5 meters and then rolled with a heavy roller. This will result in a settlement of 13 mm.

Another option is a spread footing on the dense till at an elevation of 104.3 m and designed for a maximum allowable bearing pressure of 600 kPa. However, due to the proximity of I-84 this would have to be a braced sheeting excavation.

The last option for this pier is to place it on piles with a bottom of footing elevation of 108.8 m. This would result in piles being 4.7 meters long. The piles would be cast-in-place piles, 324 and 356 mm in diameter designed for 450 and 630 kN respectively. These piles will have uplift resistance of 64 kN and 70 kN and lateral resistance of 4.8 and 5.6 kN/pile respectively.

Pier Two

This pier can be supported on spread footings at elevation 110.2 m and designed for a maximum allowable bearing pressure of 450 kPa and coefficient of sliding of 0.55. This footing would also be constructed on a 1.5 m thick pad of select structure fill (Item 203.21). Again, in order to minimize the settlement, the existing ground under the pier would have to be excavated to a depth of 1.5 m and then rolled with a heavy roller. This will result in a settlement of 13 mm.

Another option is to support the pier on a spread footing on the dense till at an elevation of 105.6 m. and designed for a maximum allowable bearing pressure of 600 kPa and a coefficient of sliding of 0.55. This excavation, depending on the final width of the footing, may be able to be progressed with an open cut.

The last option is to support the piers on piles as describe in Pier One and with a footing elevation of 110.2 m.

Conclusions and Recommendations

Location	Bottom of Footing, elevation	Foundation Type	Bearing Pressure or Pile Load	Comments
South Abutment	118.5	Spread	200 kPa	
Pier One	108.9	Piles	630 kN	356 mm CIP
Pier Two	105.6	Spread	600 kPa	Open cut w/ 1 on 1.5 sides; Only practical if done before Ramp construction
East Abutment	115.3	Spread	200 kPa	

Bridge 4 Ramp NS-L over I-84 and Ramp WB-NS

South Abutment

This abutment is supported on spread footings constructed on a MSES embankment and designed for maximum allowable bearing pressure of 200 kPa and a coefficient of sliding of 0.55. Settlement will be less than a centimeter with the waiting period described in "Waiting Periods for MSES walls".

Pier

Place the pier on a spread footing designed for a maximum allowable bearing pressure of 600 kPa and a coefficient of sliding of 0.55. The bottom of footing elevation is assumed to be 106.2. Settlement will be less than a centimeter.

North Abutment

This abutment is supported on a spread footing constructed on a MSES embankment. It can be designed for a maximum allowable bearing pressure of 200 kPa and coefficient of 0.55. Settlement will be less than a centimeter wit h the waiting periods described above in "Waiting Periods for MSES walls".

Conclusions and Recommendations

Location	Bottom of Footing, elevation	Foundation Type	BearingPressure or Pile Load	Comments
South Abutment	115.8	Spread	200 kPa	
Pier One	106.2	Spread	600 kPa	Open cut w/ 1 on 1.5 sides
North Abutment	114.9	Spread	200 kPa	

Bridge No. 5 Ramp L-NS over Access Road B Ramp EB-L

Abutments

The abutments will be supported on spread footings constructed on a MSES embankment. They will be designed for a maximum allowable bearing pressure of 200 kPa and a coefficient of sliding of 0.55. Settlement will be less than a centimeter with one of the waiting period procedures mentioned above in "Waiting Periods for MSES walls".

The waiting period procedure for the south abutment should be the same as for the south abutment of bridge two since they share an MSES wall.

Pier

The pier will be supported on a spread footing. Design the spread footing for a maximum allowable bearing pressure of 400 kPa and a coefficient of sliding of 0.55. The excavation for the footing should be able to be laid back to a safe slope.

Conclusions and Recommendations

Location	Bottom of Footing, elevation	Foundation Type	Bearing Pressure or Pile Load	Comments
South Abutment	117.2	Spread	200 kPa	
Pier One	111.6	Spread	400 kPa	Open cut w/ 1 on 1.5 sides
North Abutment	115.4	Spread	200 kPa	

Bridge 6 Ramps NS-Local & NS-EB over Ramps NS-L, EB-L & Access Road-B

Abutments

The abutments will be supported on spread footings constructed on a MSES embankment. They will be designed for a maximum allowable bearing pressure of 200 kPa and a coefficient of sliding of 0.55. Settlement will be less than a centimeter with one of the waiting periods described above in "Waiting Periods for MSES walls".

Pier

The pier may be supported on a spread footing constructed on the dense till at elevation102.8. Design the spread footing for a maximum allowable bearing pressure of 500 kPa and a coefficient of sliding of 0.55. The excavation for the footing will require a braced excavation in the median of I-84.

Since this may cause problems with design and construction the other option is to support the pier on piles. Raise the bottom of footing to elevation 105.9 which will result in piles being 3.2 meters long. Piles would be cast-in-place piles, 324 and 356 mm in diameter designed for 450 and 630 kN respectively. They would have uplift resistance of 44 and 48 kN and lateral resistance of 2.4 and 2.8 kN/pile respectively.

Conclusions and Recommendations

Location	Bottom of Footing, elevation	Foundation Type	Bearing Pressure or Pile Load	Comments
South Abutment	110.8	Spread	200 kPa	
Pier One	105.9	Piles	630 kN	356 mm CIP. Easier than a strutted excavation in the median which is required with spread footings
North Abutment	111.2	Spread	200 kPa	

Bridge 8 Ramp Local-WB (Widening of I-84 WB) over I-87

Abutments

Support the abutments on spread footings constructed on the existing embankment material. Design the footings for the maximum allowable bearing pressure of 250 kPa and a coefficient of sliding of 0.55. Settlement should be less than a centimeter if the procedure outlined in "Waiting Periods" is followed.

Pier

Support the pier on a spread footing constructed on the existing embankment material. Design the footing for a maximum allowable bearing pressure of 250 kPa and a coefficient of sliding of 0.55.

Conclusions and Recommendations

Location	Bottom of Footing, elevation	Foundation Type	Bearing Pressure or Pile Load	Comments
East Abutment	114.07 (113.808)	Spread	250 kPa	
Pier One	112.01 (111.75)	Spread	250 kPa	
North Abutment	116.13 (115.866)	Spread	250 kPa	

The elevation in parentheses are the existing footing elevations converted using CORPSCON.

SUMMARY

We have endeavored to use spread footings wherever it was practicable. The allowable bearing pressures were dictated by where the footing was located:

- Footings in an existing slope are 250 kPa
- Footings located on MSES are 200kPa. This is based on the location of the toe relative to the wall having panels with a nominal amount of soil reinforcement.
- The pier footing bearing pressures are determined by the strength of the soil, the amount of the overburden and location of the water table. They are based upon a nominal footing width. These bearing capacities can be re-analyzed as the design is finalized.

In discussions with Dianne Denniston at the Thruway, it was decided that any of the deeper foundations that required a braced excavation for support would be a pile foundation. This is assuming that it will be easier to drive piles than deal with struts for the excavation support passing through the pier stem. If this is not the case, that is if the reinforcing spacing is such as to allow the passage of the struts, then an economic analysis would be necessary to determine what would be the most economical foundation.

Lateral load capacities of the piles can be refined as the design progresses.

Once the designers have had a chance to digest the information, it may be advisable to have a meeting about refinements.

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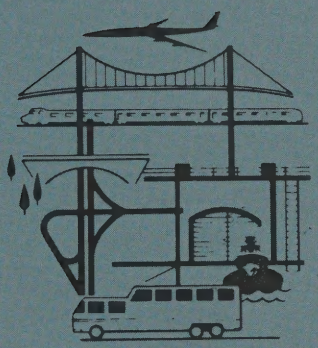

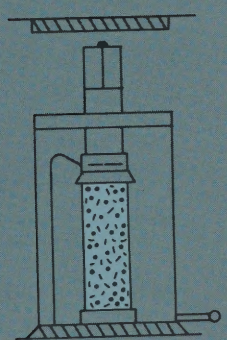

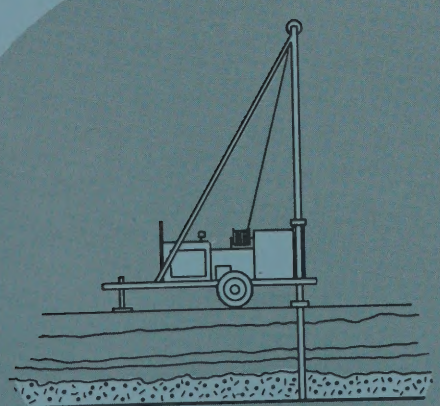

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